CORNELL UNIVERSITY LEPP
LABORATORY FOR ELEMENTARY-PARTICLE PHYSICS

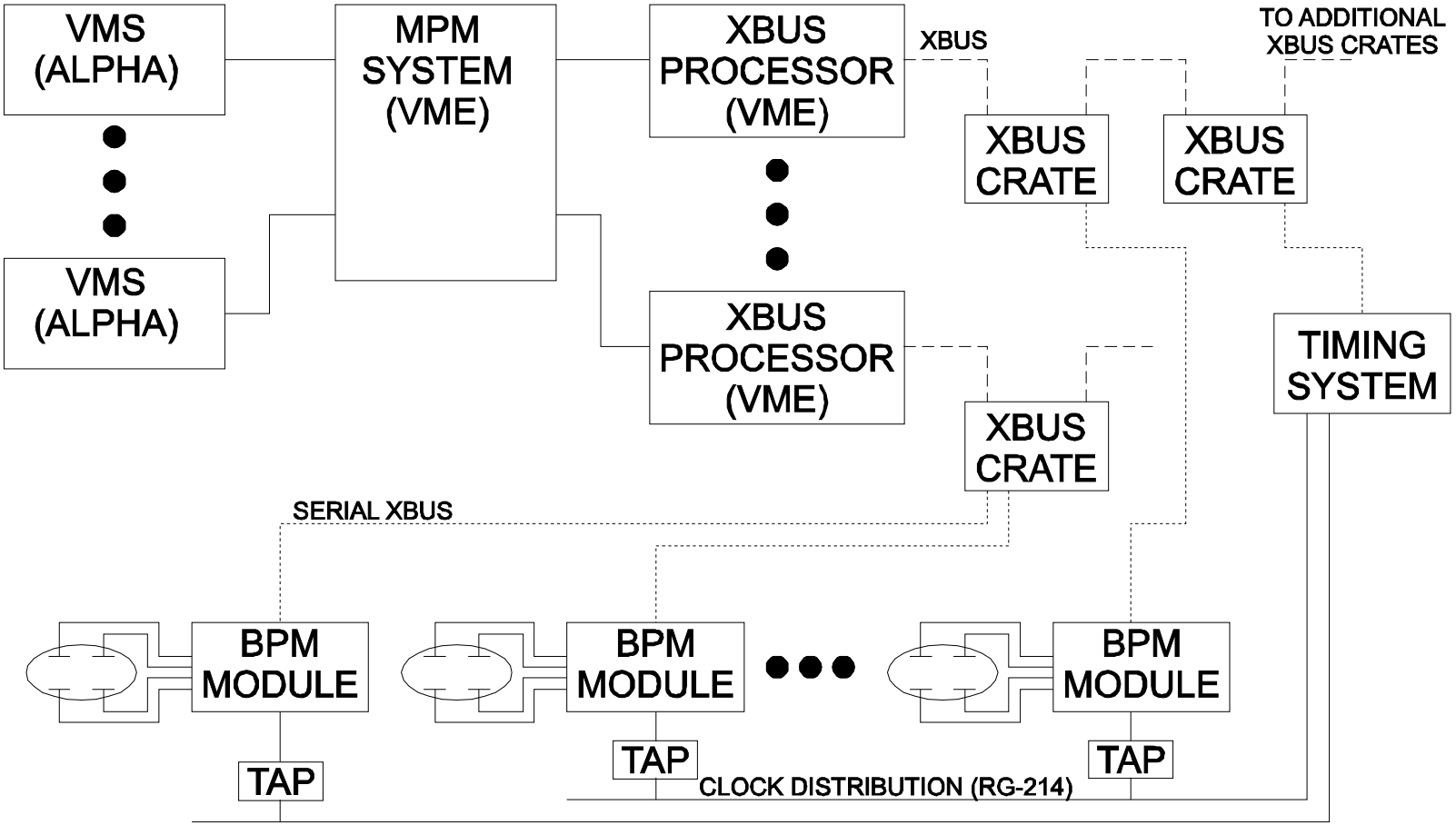
Bunch Instrumentation DAQ

- Instrumentation Hardware and Measurements
- Instrumentation Embedded Software/Firmware
- Communications/Data Translation/Low-level Control
- Calibration and Constants
- System Control Tools
- User Interface/Control System Interface
- Data Handling and Analysis
- System Visualization Tools
- Infrastructure for Building/Maintaining Codes

Comments

- Timescale
  - Maximize operational capability by next CLEO-c run
  - 5-6 month results are *critical*
  - Flexibility for use until end of CESR (mid-2008 for HEP, 2012? for CHESS) is *important*
- Manpower
  - Draw on experience base for design and supervision
    - Specifications
    - Templates
    - Examples
  - CLEO offering student/postdoc support to gain hardware experience (*and luminosity*)
  - CESR staff support
- Goals
  - Provide code for ***all standard*** operating scenarios
  - Provide DAQ *skeleton* that can support important features
  - Implement features that are rated *critical*
  - Allow for modular construction so that other features can be added when/if they become necessary (*enable students/staff to implement specific applications)*
  - *The most critical feature is a detailed plan capable of supporting short-term implementation and long-term operation/evolution of systems*

System Layout



Key Feature: SERIAL-XBUS protocol provides 10K word/sec of transmission bandwidth all major processing must occur in DSPs, particularly when servicing many BPMs

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Hardware/Measurements

- Beam Position Monitors
  - Continuous beam position
    - Orbit monitoring
    - Differerential orbit monitoring
  - Orbit requests
  - Phase requests
  - Turn-by-turn trajectory requests
  - Bunch tunes (continuous or by request)
  - Calibration
    - Pedestals
    - Bunch Timing
    - Turn Timing Logic
  - Real-time tune monitor
- Luminosity Monitor
  - Continuous bunch luminosity
    - Photon Counting
    - E over threshold
    - Beam losses
  - Calibration requests
    - MCA (calibration/rad damage)
    - Bunch Timing
    - Pedestals
    - Turn Timing Logic
  - Real-time FE development/support
- Beam Profile Monitors
  - Real-time Differential Vertical Size
    - Interferometer analysis
    - Gaussian profile analysis
  - Calibration
    - Pedestal
    - Bunch Timing
    - Channel cross-talk
    - Turn Timing Logic
  - Integrate into beam dynamics measurements
- Control System Integration/Machine Studies Measurements
  - Grad student projects
  - Accelerator group support
- Who?
  - Dobbins (FEs, timing, test, support hdw)
  - Strohman (dig, test, PS, timing dist)
  - Palmer (requirements/DSP soft/CTL soft)
  - Codner (CTL applications)
  - Tanke (testing/DSP software)
  - Watkins (interferometer algos)
  - Taylor (xray profile monitor algos)

Embedded Software/Firmware

- General Requirements
  - Test suite for each DSP
  - Support for standard setup/command/trace/debug operations
  - Calibration and analysis algorithms by detector type
  - Support routines by DSP type
  - Firmware for new FEs with algos running in PLDs
  - General library structure for stability and reusability of code
  - Coding standard to support shared code between different architectures
  - Source code maintained as part of CESR CVS repository on Unix
- Status
  - Already have a fairly complete suite of code for 1st generation CBPM modules
  - Preliminary test suite for 2nd generation modules in use and being expanded
  - First algorithms for 2nd generation modules under development (installation of FLM module soon)
  - Visual DSP++ supports makefiles and code libraries. Working on switchover from project by project builds
- Who
  - Palmer/Tanke for support codes
  - Palmer/Watkins/Taylor for applications

Communications/Low-Level Control

- General Requirements
  - Standard control/status/ debugging/trace interface to ***ALL*** module types
  - Mirroring of DSP data structures for debugging and data transfer
  - Automated tools to set up definitions of mirrored data structures and the communications protocol for each

```
typedef struct {
        int cmd;
        int cmd_status;
        int error[MX_ERROR_WORDS];
        int handshake;          // handshake MUST BE LAST!
  } CBPM_XBUS_CMD;

// CBPM_XBUS_CMD configuration
static const COMM_KEY_CONFIG xbus_cmd_cfg = {
      "XBUS_CMD",                          // name
      XBUS_CMD_TAG,                        // ctl_tag
      XBUS_CMD_TAG,                        // dsp_tag
      GENERIC_EXE,                         // exe_allowed
      1,                                   // num_pkts
      4,                                   // num_vars
      CTL_READ_WRITE,                      // protection
      FIXED_REC_LENGTH,                    // rec length flag
      {T_INT,  T_INT,  T_INT,  T_INT},     // data types
      {1, 1, MX_ERROR_WORDS, 1},           // data counts
      {1, 1, 1, 1},                        // element sizes
      {cbpm_int_convert, cbpm_int_convert,
       cbpm_int_convert, cbpm_int_convert},      // conv function ptrs
      NULL,                                // custom copy/check data function
      cbpm_struct_io                       // IO function
  };
```

- Status
  - DSP communications interface developed for 1st generation CBPM system
    - Transfer C data structures as XBUS packets (image DSP memory)
    - Control/handshaking methods
    - Debug/Trace methods
    - Input parameter validation methods
    - Communications protocol
      - Data translation
      - Data mapping
  - Parser tool
    - Automated setup of matched DSP/Control headers and generation of communications initialization code
- Who
  - Strohman/Palmer
  - Taylor (*Isaacman*)

Calibration and Constants

- General Requirements
  - Need to support a large range of constants for each module
    - Gain calibration
    - Pedestal calibration
    - Timing calibration
    - Turn logic info by bunch
    - Basic detector information
    - MPM node/element mapping
  - 1st generation system saves approx. 1000 pieces of information per module
  - Visualization, history tools, and searching would be nice
- Status
  - 1st generation implementation
    - Tagged configuration file saved upon request when calibrations run
    - Files manually checked and rotated into *default* constants file when needed
- Who
  - Palmer

System Control Tools

- General Requirements
  - Ability to operate multiple hardware and software combinations
    - BPM system will have 2-3 hardware types and 2-3 (or more) DSP software versions
    - Synchronous measurements between system
  - Uniform control interface
- Status
  - Present control loop can handle single hardware/software type
  - Readily expandable
  - Communication and low-level control tools already have been developed to support this (in testing phase)
- Who
  - Palmer, Taylor

User/Control System Interaction

- General Requirements
  - Individual systems available for *requests for standard event data* via server
  - Provide (*some*) *streaming data* for direct control system monitoring (also see following slide)
  - Provide interface for *users* to run *customized* data requests (also see following slide for data issues)
    - Need to specify interaction with server
    - Custom requests may require significant re-initialization when control returned to server
  - Monitoring/Config/Control GUI would expedite maintenance and user interactions
  - Standard user input tools to avoid "crashing" system
- Status
  - Standard CBPM server available for orbit, phase, turn-by-turn trajectory measurements
  - Does not offer full configuration capability
  - Needs better implementation of interrupts and failure recovery
  - User interface through command line menu. Can disable server for long periods (probably need to add interrupt capability)
  - Standardized user input methods with parameter checking to protect low-level processors
- Who
  - Palmer (*Rock)*

Data Handling/Analysis

- General Requirements
  - Support single layer of thinned out data to MPM
  - Allow access to detailed data at *requesting program* level
    - Shared memory on server node
    - User analysis directly in *requesting program*
  - Allow for new communications path (ethernet) for large bandwidth limited data
  - Support *event-like* and *streaming* data
  - Interface routines for Fortran analysis
- Status
  - Present methods
    - Buttons/phase data written to MPM for standard requests
    - Trajectory data written to file for user read/analysis/display
    - Differential orbit data written to file for user read/analysis/display
    - Calibration data wirtten to file for user read/analysis/display
- Who
  - Palmer

System Visualization Tools

- General Requirements
  - Built-in package for visualization has been requested
    - Large data size
    - Range of data to examine
    - Desire for standard, easily accessible tools
- Status
  - At present, no *built-in* visualization tools provided
  - Accelerator group tools for plotting MPM data
  - User tools for plotting saved data
- Who
  - Codner

Infrastructure
Code Building/Maintenance

- General Requirements
  - Code maintained in CESR CVS repository on Unix
  - OSF testing of many tools (on CESR machines) is acceptable
    - Compilers on cesrxx OSF machines match VMS compilers
    - More development CPU cycles available
    - Porting tools to move code to VMS and test
  - Multiple source library implementation to support shared source among several applications
    - Control codes
    - DSP codes
    - Control/DSP codes
  - Suitable coding standard to handle code that can be run across multi-DSP and CTL architectures
  - Restrict development to tools available (or portable) to VMS
  - Versioned releases for stability and problem tracking
- Status
  - Repository structure in place
  - Porting structure in place
  - CesrBPM and utiltiy libraries (1st generation system) in place with versioning checks
  - Range of new codes ready for import into repository
- Who
  - CESR Librarian: Valeriu Smiricinschi
  - Palmer

Library Hierarchy